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Formulation and Characterization of herbal Emulgel by using four Tradesman herb *Tamarindus indica, Achyranthes aspera, Nyctanthes arbor-tristis, Syzygium cumini*

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ABSTRACT

Topical drug administration is the localized administration of medication to any area of the body via the cutaneous, vaginal, ophthalmic, and rectal channels. Whether their skin is healthy or sick, they employ a wide variety of dermatological and cosmetic treatments on it. The synthesis and characterization of an herbal emulgel incorporating four traditional medicinal plants, namely *Tamarindus indica, Achyranthes aspera, Nyctanthes arbor-tristis,* and *Syzygium cumini*, are described. The emulgel formulation was prepared using a combination of natural emulsifiers and gelling agents to achieve stable emulsion and gel properties. The phytochemical analysis of the herbal extracts revealed the presence of bioactive compounds such as flavonoids, alkaloids, phenols, and tannins, known for their therapeutic effects. The emulgel was characterized for its physicochemical properties including pH, viscosity. Additionally, the emulgel was evaluated for its in vitro antioxidant activity using DPPH assay, Anti-microbial test by *Escherichia coli* and in vitro anti-inflammatory activity using the animal method. The results indicated that the herbal emulgel exhibited significant antioxidant and anti-inflammatory activities, attributed to the synergistic effects of the bioactive compounds present in the herbal extracts. Overall, the formulated herbal emulgel holds promise as a natural alternative for topical applications, offering antioxidant, antimicrobial and anti-inflammatory benefits, which could potentially find applications in the pharmaceutical and cosmetic industries.

Keywords: Emulgel; Topical drug administration; Therapeutic effects; Antioxidant; Anti-microbial; Anti-inflammatory; Phytochemical analysis; Traditional medicine; Bioactive compounds; Pharmaceutical.

1. Introduction

Topical drug administration is the localized administration of medication to any area of the body via the cutaneous, vaginal, ophthalmic, and rectal channels. Whether their skin is healthy or sick, they employ a wide variety of dermatological and cosmetic treatments on it. These formulations range in physicochemical nature from solid to semisolid to liquid [1]. Drug ingredients are often administered as a formulation including one or more non-medicinated chemicals with a range of specialized pharmaceutical applications rather than as an ingredient in and of itself. Drugs are administered topically to act locally or to have systemic effects. If the medication is in solution, has a favorable lipid/water partition coefficient, and is a non-electrolyte, its absorption via the skin is improved. Pharmaceutical preparations administered topically are primarily designed to have a localized effect; as such, they are designed to offer extended local contact with little systemic drug absorption [2]. Drugs used topically for their localized effects on the skin include protectants, emollients, antiseptics, and antifungal agents. The primary benefit of using a topical administration technique is that it avoids the first-pass metabolism. Other benefits of topical preparations include avoiding the hazards and hassles associated with intravenous therapy as well as the various circumstances of absorption such as pH fluctuations, the presence of enzymes, and stomach emptying time. The topical medication delivery method is typically employed in situations where other drug administration methods are ineffective, or it is mostly used to treat fungal infections. Human skin is a specially designed organ that sustains life on Earth by controlling body temperature and water loss while blocking the entry of harmful substances or microbes [3]. It is also the biggest organ in the human body, making up 10% of the typical person's body mass and occupying an average area of 1.7 m^2. Despite the fact that the human skin is a large, easily accessible organ that

is meant to keep the outside world out and the inner world in, it is a very powerful, self-repairing barrier that has numerous places for delivering therapeutic chemicals for both local and systemic activity. Gels are a relatively new class of dosage forms in which large volumes of aqueous or hydroalcoholic liquid are trapped in a network of colloidal solid particles [2]. These particles can be either organic—such as manufactured or natural polymers—or inorganic—such as aluminum salts. Compared to the ointment or cream basis, they feature a larger aqueous component that allows for increased drug solubility and easier drug migration via a vehicle that is virtually a liquid. They are better in terms of patient acceptance and ease of usage. Gels have numerous benefits, but one significant drawback is their inability to distribute hydrophobic medications. Therefore, to overcome this constraint, emulgels are created and employed so that even a hydrophobic medicinal moiety can enjoy the special features of gels [4].

1.1. *Tamarindus indica*

Contrary to pharmaceuticals, traditional medicine is readily available and useful, particularly in tropical nations, and as such, it plays a significant role in the first line of treatment. For instance, 90% of people in Burkina Faso favor using traditional treatment. The cornerstones of conventional medicine are plants, which are also becoming more and more popular as therapeutic options.

Medicinal Use: Gastrointestinal system and related disorders, Cancer, Antimicrobial, antiparasitic, antifungal, antiviral, antinematodal features, Anti-inflammatory effect, Antioxidant properties, Anti-diabetic effect, Effects on cardiovascular system, Anti-diabetic effect, Liver protective effect, Weight control effect, Effect on fluoride, toxicity.

1.2. *Achyranthes aspera*

Since ancient times, plants have been considered potential sources of medicine. Strong medicinal substances are developed in large part by the use of medicinal plants. The usage of plant-based health products has skyrocketed recently in both developed and developing nations, leading to an exponential expansion in the worldwide market for herbal goods. Research on herbals has shown an increasing tendency. Herbal remedies have a solid theoretical or traditional foundation and the potential to be just as safe and successful as pharmaceuticals in the treatment of certain illnesses.

Medicinal Use: Anti-oxidant Activity, Thrombolytic activity, Antimicrobial Activity, Spermicidal Activity, Antiparasitic Activity, Hypoglycemic Activity, Cancer Chemo preventive Activity, Analgesic and antipyretic activity, Anti-inflammatory and anti-arthritic activity, Nephroprotective Activity, Anti-depressant Activity, Diuretic Activity, Bronchoprotective Activity, Hypolipidemic Activity.

1.3. *Nyctanthes arbor-tristis*

One species of Nyctanthes that is indigenous to South and Southeast Asia is *Nyctanthes arbor-tristis*. It goes by several names, including coral jasmine, tree of sorrow, night-blooming jasmine, and seri gading in Singapore. The plant is not a "true jasmine" and is not a member of the genus Jasminum, despite its common name.

Medicinal Use: Anti-inflammatory effect, Antioxidant properties, Anti-diabetic effect, Antimicrobial Activity, Hepatoprotective Activity, Nervous Disorder, Wound healing.

1.4. *Syzygium cumini*

Syzygium cumini is an evergreen tropical tree in the flowering plant family Myrtaceae, valued for its fruit, lumber, and decorative qualities. It is also referred to as Malabar plum, Java plum, black plum, jamun, jaman, jambul, or jambolan. It is indigenous to Southeast Asia, which includes Bangladesh, Myanmar, Sri Lanka, and the Andaman Islands, as well as the Indian subcontinent. It may survive for more than a century and soar to heights of up to 30 meters (98 feet). This fast-growing plant is regarded as an invasive species in many parts of the world. Australia, Hong Kong, Singapore, and islands in the Pacific and Indian oceans are among the places where *Syzygium cumini* has been introduced.

Medicinal Use: Anti-inflammatory effect, Antioxidant properties, Anti-diabetic effect, Antimicrobial Activity, Anti-viral, Anti-fertility, Anti-histaminic, Wound healing.

2. Material and Methods

2.1. Processing of the Plant Material

The plant was collected from ITM University medicinal garden Gwalior lives was dried and was powdered. This powder was further used to obtain the extract.

2.2. Extraction of plant material

The Soxhlet apparatus's fourth assembly was taken out. The Soxhlet equipment was used to extract the powdered lives using ethanol. This extract was concentrated even more (Figure 1 Soxhlet apparatus) [6].

Figure 1. Soxhlet apparatus

2.3. Preformulation studies

2.3.1. Preliminary Phytochemical Screening: The process of phytochemical screening is used to detect the presence of various phytoconstituents. Ethanol was used to dissolve the extract. It was filtered, and tests for

alkaloids, flavonoids, carbohydrates, tannins, saponins, steroids, terpenoids, and other substances were performed on the filtrate (Table 2 Phytochemical Screening of *Tamarindus Indica*, Table 3 Phytochemical Screening of *Achyranthes aspera*, Table 4 Phytochemical Screening of *Nyctanthes arbor-tristis*, Table 5 Phytochemical Screening of *Syzygium cumini*) [7].

2.3.2. Solubility analysis: A modest incremental quantity of the solute is added to a set volume of solvents, such as ethanol, chloroform, acetone, and distilled water, to perform a solubility analysis. Next, any undissolved particles are checked for (Table 6 Solubility analysis of extract) [7].

2.3.3. Melting point: Using the conventional melting point determination method, the melting point of the extracted material was determined.

2.3.4. Confirmation of drug using UV-Vis Spectrophotometric method: 6.8 phosphate buffer was chosen to produce the calibration curve. To produce a concentration of 1000 ppm, 100 ml of phosphate buffer was diluted with 100 mg of crude extract, and this was used as the stock solution. This stock solution was diluted further to acquire different concentrations. The resulting solutions were subjected to a UV spectrophotometer and a 400–700 nm UV–VIS spectrophotometer scan for λmax (Figure 2 200-400 nm using UV spectrophotometer, Figure 5 400-700 nm using UV spectrophotometer) [8].

2.3.5. Confirmation of drug using FT-IR method: Crude extract was under examine in Wavenumber cm^{-1} (4000 to 500) and Transmitten % (5000 to 25000) (Figure 5 400-700 nm using UV spectrophotometer) [9].

2.4. Formulation of emulgel

There are three basic steps involved in the preparation of emulgel:

Step 1: Formulation of emulsion, which can be either O/W or W/O.

Step 2: Formulation of a gel base by adding gelling agents and water by constant stirring and optimization of their pH.

Step 3: Incorporation of the emulsion into gel base with continuous stirring and heating (Table 1 Chemical use in Emulgel).

Make sure it is cooled to room temperature. The emulsion is added to the gel base with a ratio of 1:1 for the formation of emulgel (Figure 2 Emulgel, Figure 3 Formulation F-01, F-02).

Figure 2. Emulgel

Figure 3. Formulation F-01, F-02

Table 1. Chemical use in Emulgel

S. No.	Chemical Use	Blank	F-01	F-02
01	Tween 80	2ml		
02	Span 80	25ml		
03	Light liquid paraffin	10ml		
04	Ethanol	5ml		
05	Propylene glycol	5ml		
06	Propyl paraben	0.2gm		
07	Carbapol	1.3gm		
08	Triethanolamine	0.3ml		
09	Water	qs.		
10	*Tamarindus Indica* extract	-	30mg	60mg
11	*Achyranthes Aspera* extract	-	30mg	60mg
12	*Nyctanthesarbor*-tristis extract	-	60mg	30mg
13	*Syzygium cumini* extract	-	60mg	30mg

3. Evaluation of Emulgel

3.1. Physical Examination: The prepared emulgel formulations are inspected visually for their colour, and appearance (Table 7 Physical Examination) [6].

3.2. pH Evaluation: Evaluation of pH is a crucial factor, particularly for topical formulations. To match the skin's pH, the emulgel's should be between 5-7. Patient discomfort may result from an acidic or basic pH in the manufactured emulgel. A digital pH meter was used to measure the emulgel's pH. After dissolving 1 gram of gel in 100 ml of distilled water, the mixture was left for 2 hours. Afterwards, the glass electrode was dipped into an emulgel. Each formulation's pH was measured three times, and the average results were determined (Table 8 pH Test) [1].

3.3. Viscosity: Viscosity was maser by viscometer (Table 9 Viscosity).

3.4. Antimicrobial study: Types of bacteria chosen based on their susceptibility Assay: Escherichia coli was one of the two bacteria that were chosen for this investigation. At 37 °C, the bacterial cultures were maintained in nutrient agar slants (Figure 8 Anti-microbial test, Table 11 Anti-microbial test) [5].

3.5. Anti-oxidant study: By monitoring the change in optical density of DPPH radicals, the test materials' ability to scavenge free radicals to assess their antioxidant capacity is assessed (Figure 7 Anti-oxidant, Table 10 Anti-oxidant test) [8].

3.6. Examining the anti-inflammatory properties using the rat paw edema technique caused by carrageenan

In the preset study, approximately half an hour was spent preparing one suspe sio of CRR Gee. Before to the experiment and was injected into the rat's right hind paw's plantar area. 0.2 gm of F-02, were applied to the test groups' right hind paws' plantar surfaces and lightly rubbed with the index finger. The gel base was the only treatment given to the rats in the control group; the same procedure was followed when applying the standard gel, Diclofenac. Following an hour of gel base application, a topical preparation of F-02; µl of 1 suspe sio of carrageenan in saline was applied to the rat's right hind paw's plantar area. Using a plethysmometer, paw volume was measured immediately following carrageenan injection at one, two, three, and four hours. The paw volume was measured at various intervals. Using the following formula, the percentage inhibition in paw volume was determined [09]:

$$\% \text{ Inhibition} = \frac{\text{Paw volume (control)} - \text{Paw volume (test)}}{\text{Paw volume (control)}} \times 100 \quad (1)$$

(Table 12 Anti-inflammatory test, Figure 9 Anti-inflammatory graf).

4. Results and Discussion

4.1. Preformulation studies results

4.1.1. Determination of melting point: It was discovered that the ginger extract has a melting point of 32 °C.

4.1.2. Phytochemical Screening

Table 2. Phytochemical Screening of *Tamarindus indica*

S. No.	Test Name	Result
01	Alkaloids	+
02	Flavonoids	-
03	Saponins	+
04	Steroids	+
05	Glycosides	+
06	Carbohydrates	+
07	Proteins	+
08	Terpenoids	-

Table 3. Phytochemical Screening of *Achyranthes aspera*

S. No.	Test Name	Result
01	Alkaloids	+
02	Flavonoids	+
03	Saponins	-
04	Steroids	-
05	Terpenoids	-
06	Phenol	+
07	Tannin	-
08	Coumarin	+

Table 4. Phytochemical Screening of *Nyctanthes arbor-tristis*

S. No.	Test Name	Result
01	Alkaloids	+
02	Flavonoids	+
03	Saponins	+
04	Steroids	+
05	Terpenoids	+
06	Reducing Sugars	+
07	Anthraquinones	-
08	Tannin	+

Table 5. Phytochemical Screening of *Syzygium cumini*

S. No.	Test Name	Result
01	Phenolics	+
02	Tannin	+
03	Flavonoids	+
04	Phytosterols	+
05	Triterpenoids	+
06	Alkaloids	+
07	Saponins	-
08	Glycosides	-
09	Carbohydrates	+

4.1.3. Solubility analysis: Solubility of the *Tamarindus Indica*, *Achyranthes aspera*, *Nyctanthes arbor-tristis*, *Syzygium cumini*, extract in various solvent.

Table 6. Solubility analysis of extract

Name of extract	Water	Ethanol	Chloroform	Acetone
Tamarindus indica	++	++	++	++
Achyranthes aspera	++	++	++	++
Nyctanthesarbor-tristis	++	++	++	++
Syzygium cumini	++	++	++	++

4.1.4. Confirmation of drug using UV-VIS Spectrophotometric method

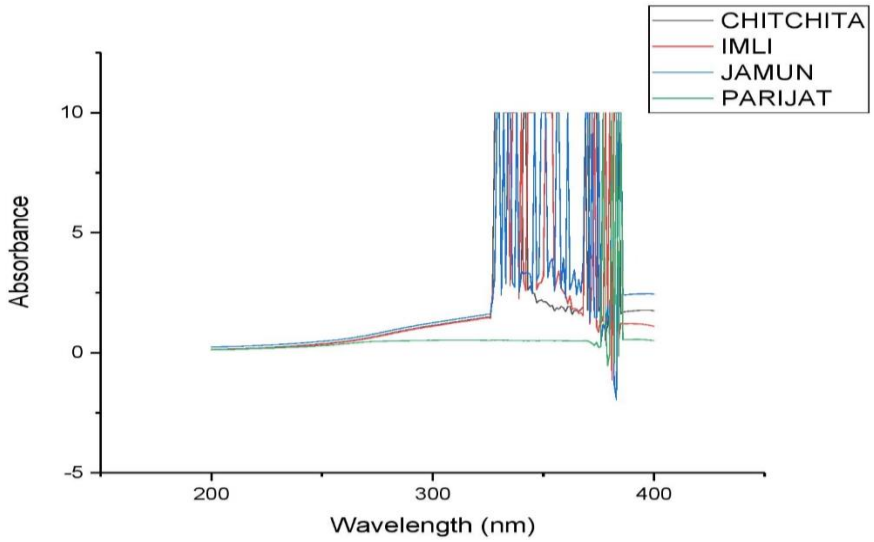

Figure 4. 200-400 nm using UV spectrophotometer

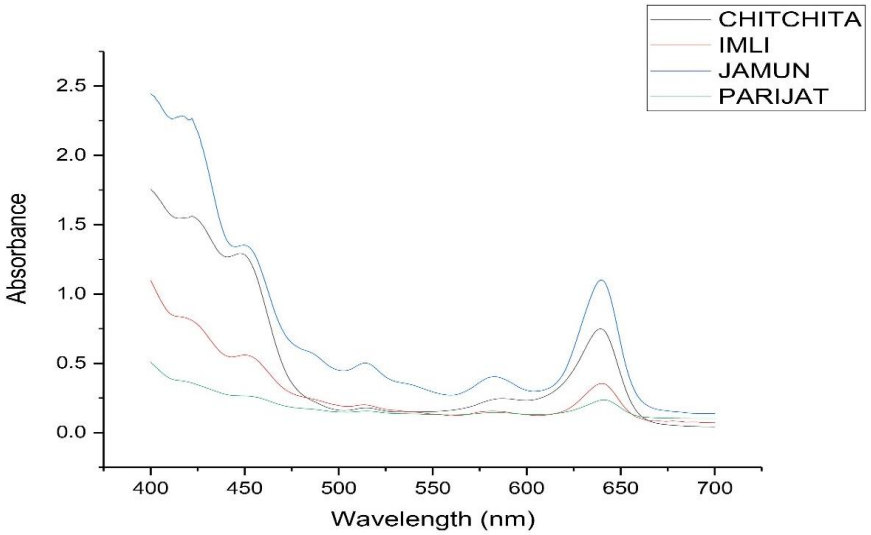

Figure 5. 400-700 nm using UV spectrophotometer

4.1.5. Confirmation of drug using FT-IR method

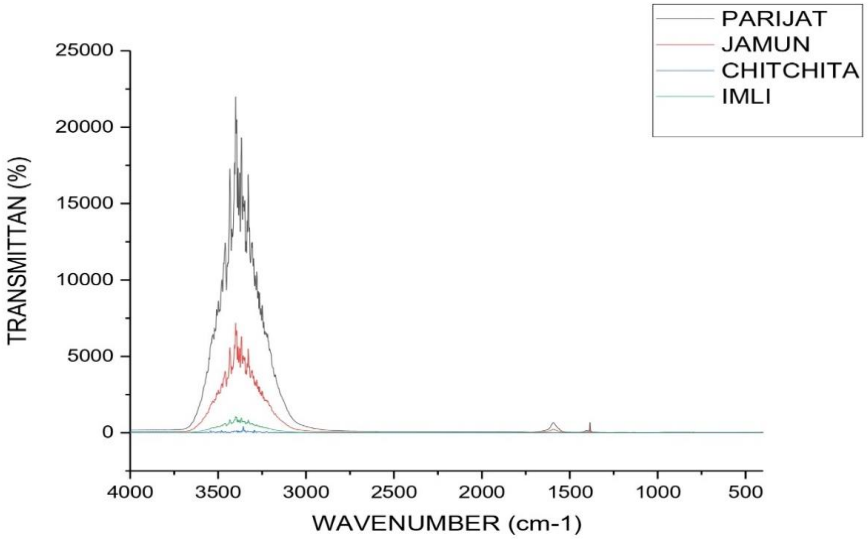

Figure 6. FT-IR

4.2. Evaluation of Emulgel

4.2.1. Physical Examination

Table 7. Physical Examination

S. No.	Test parameter	Result
01	Colour	Light green
02	Phase Separation	None

4.2.2. pH Test

Table 8. pH Test

S. No.	Sample Name	Result
01	Blank	6.58
02	F- 01	6.67
03	F- 02	6.69

4.2.3. Viscosity

Table 9. Viscosity

S. No.	Sample Name	Result
01	Blank	3811±0.27cp
02	F- 01	3820±0.27cp
03	F- 02	3826±0.2cp

4.2.4. Anti-oxidant

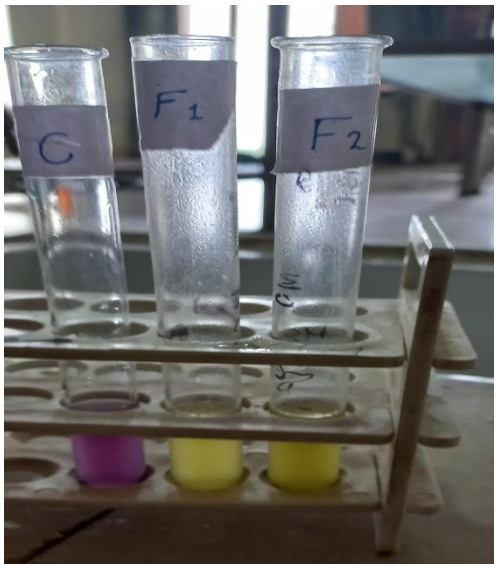

Figure 7. Anti-oxidant

Table 10. Anti-oxidant test

S. No.	Sample Name	Colour	Result
01	C (Blank)	Purple	---
02	F- 01	Yellow	++
03	F- 02	Yellow	+++

4.2.5. Anti-microbial Test

Figure 8. Anti-microbial test

Table 11. Anti-microbial test

S. No.	Sample Name	Microbe Name	Result
01	C (Culture media)	Blank	Blank
02	B (Culture media + Microbe)	*Escherichia coli*	+++

03	C_F (Culture media + Microbe + Blank formulation)	*Escherichia coli*	++
04	F_1 (Culture media + Microbe + Formulation)	*Escherichia coli*	-
05	F_2 (Culture media + Microbe + Formulation)	*Escherichia coli*	-

4.2.6. Examining the anti-inflammatory properties using the rat paw edema technique caused by carrageenan

Table 12. Anti-inflammatory test

S. No.	Time (h)	% Inhibition of edema		
		Control (without drug)	Standard (Diclofenac gel)	Test (F-02)
01	01	24.21	33.12	26.32
02	02	29.33	60.51	59.59
03	03	33	77.57	77.13
04	04	36.21	95.23	86.94

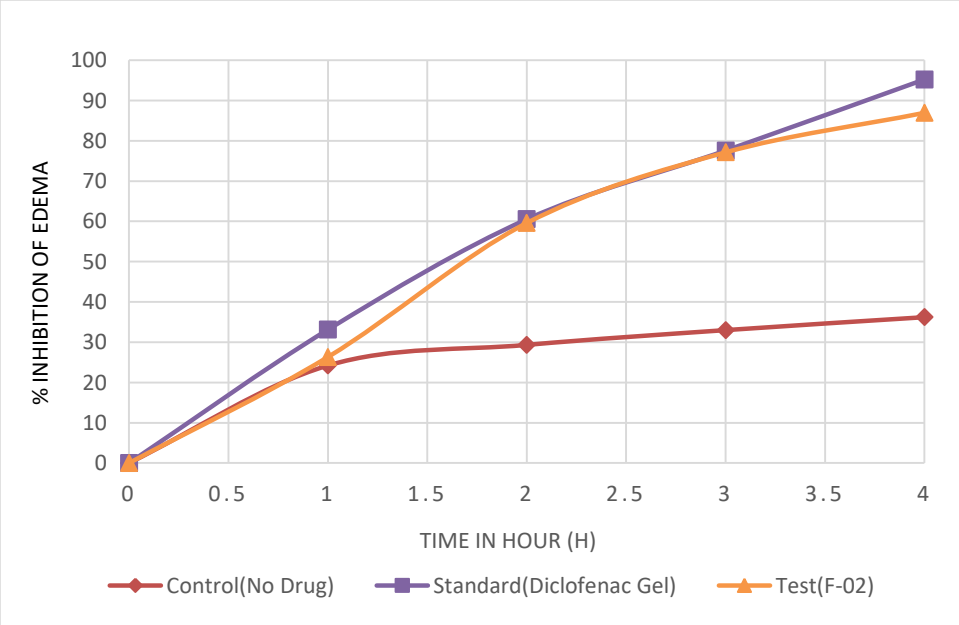

Figure 9. Anti-inflammatory graf

5. Conclusion

Among topical medication delivery applications, emulgel is the most advanced technique used. In both formulation F-01 and F-02, F-02 is batter then F-01. Its Colour-light green, Phase Separation-None, pH-6.69, Viscosity-3826±0.2 cp, Good anti-oxidant property, Good Anti-microbial activity.

Declarations

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This study did not receive any grant from funding agencies in the public, commercial, or not-for-profit sectors.

Competing Interests Statement

The authors declare no competing financial, professional, or personal interests.

Consent for publication

The authors declare that they consented to the publication of this study.

Authors' contributions

All the authors took part in literature review, analysis and manuscript writing equally.

Availability of data and material

All data pertaining to the research is kept in good custody by the authors.

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